Life Cycle Costing Data for Roadways: A Precis

A Town+Gown Symposia Event

New York Public Library Branch @ 455 Fifth Avenue

February 22, 2012 (8:30 a.m. to 10:30 a.m.)

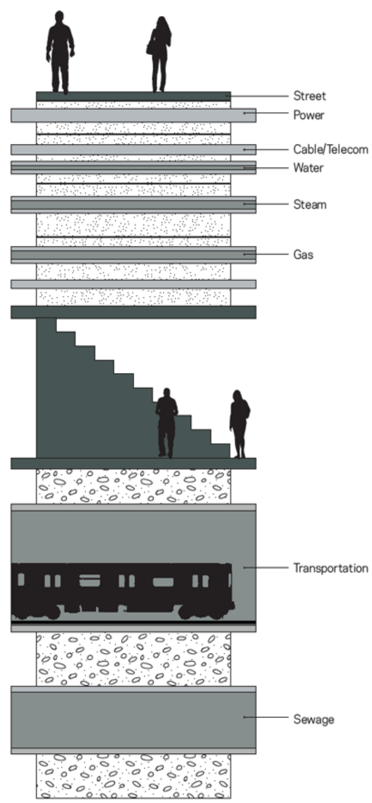
June 2006: Value Management Study on Roadway Repair Technology and Best Practices. In a structured workshop process, city agencies involved in roadway construction investigate ways to improve and maintain street infrastructure at a lower cost per mile, with less disruption. A primary objective was to develop a menu of technologies and techniques to maintaining roadway life expectancy between resurfacings in the context of limited resources.

April 2007: PlaNYC 2030. This long-term plan aims to ensure a sustainable, economically viable metropolitan center by 2030, informed by concerns for challenges posed by growing population, global warming, aging infrastructure, climate change, and an evolving economy. *See* http://www.nyc.gov/html/planyc2030/html/theplan/the-plan.shtm

May 2009: New York City Street Design Manual. This practical compilation of City processes and guidelines for street design and construction assists in setting appropriate goals for each street project, providing a framework for design decisions, establishing a clear and consistent design review process and serving as a central, comprehensive reference guide. The range of standards is intended to foster innovative design and construction and sustainable materials use. *See* http://home2.nyc.gov/html/dot/html/about/streetdesignmanual.shtm

December 2009: Comprehensive Street Management Plan. A multi-phase investigation of the city's street management practices and policies by street component part creates opportunity for changes in capital planning and budget practice and policy based on research and analysis.

September 2010: *NYC Green Infrastructure Plan.* This alternative approach to improving water quality focuses on all built environment impacts on the watershed, including the streets and sidewalks, integrating storm water management into the street-related components of the capital program. *See* http://home2.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_plan.shtml



Source: DOT Street Works Manual

Almost 27 percent of the city's land area, which is also its combined sewer watershed, is covered by streets and sidewalks, which form the top layer of a complex set of systems, different components of which are owned and operated by various private and public owners. The city roadway is itself a complex physical asset, containing or integrated with parts of many of the other systems: mass transit, steam heat, telecommunication and electric utilities, and drinking water and wastewater. The performance of the city's various inter-related systems is directly related to the city's performance across a number of criteria.

Supporting current and future urban functions in the context of PlaNYC's environmental sustainability paradigm requires public owners to actively manage—maintaining and/or expanding—their transportation infrastructure assets to ensure the highest return on investment, while safeguarding the quality of the environment. Bringing the future condition of the environment into investment analyses requires expanding its time horizon and the types of costs and benefits to be considered.

The city's capital planning process consists of three planning tools—the ten-year capital strategy, the four-year capital plan and the current-year capital budget—each with a different time horizon and function. The ten-year capital strategy is a long-term planning tool designed to reflect fundamental allocation choices and basic policy objectives. The four-year capital plan translates mid-range policy goals into specific projects. The capital budget defines for each fiscal year specific projects and the timing of their initiation, design, construction and completion. The following chart provides a snapshot of roadway capital allocations.

	2012-2021 Ten-Year Capital Strategy	**2102-2015 Capital Commitment Plan**
Reconstruction or resurfacing of City streets	4 percent	10 percent (aggregate)
Bridge construction and rehabilitation	6 percent	
Water and sewer system improvements	23 percent	23 percent
City-funded investment in mass transit	1 percent	2 percent

Source: Official Statement, dated September 28, 2011.

A fourth planning tool, the asset information management reporting process, estimates capital and expense needs generated by existing facilities. For assets and asset systems with a replacement cost of $10 million or more and a useful life of at least ten years, the city annually assesses their condition and proposes a maintenance schedule. This "state of good repair" assessment and proposed maintenance schedule, however, does not reflect any policy considerations affecting the appropriate amount of investment, such as changes in demand for or planned future use of the asset. The city's four-year capital plan, for fiscal years 2012 through 2015, funds 48% of the total recommended "state of good repair" investment, and the city estimates that 71% of the recommended expense maintenance levels was included in the last financial plan.

While the city's "big-picture" layered capital planning process, described above, helps the city plan for future capital needs, the formal four-year financial plan period creates a short analytical horizon compared with the life cycle of the assets the capital budget finances, which tends to discourage project investment analyses that includes life cycle costs and benefits. Since traditional financial analysis approaches overlook many of the benefits and costs as they relate to environmental impact, planning analyses for capital projects may not present their true lifetime net worth, leading to less than optimal capital project decisions and portfolios.

In this context, DOT and DDC partnered with a NYU/Wagner capstone student team (the "Team") to investigate how the city might incorporate life cycle cost analyses for long-term investment decision-making and develop a project appraisal framework capable of capturing the true benefits of sustainable streetscape projects. While current capital planning and budget mechanisms aim to ensure that street and public space projects make the most efficient use of taxpayer funds, they do not currently take life-cycle costs into consideration, nor do they account for externalities, including cross-system benefits. The study, "Transitioning into Lifecycle Cost Analysis", outlines an adaptation of the traditional Net Present Value (NPV) approach to address two stated objectives: first, to determine whether the use of different and more environmentally sustainable materials in streetscaping projects would be more cost effective in the long-term than standard alternatives; and second, to determine whether upgraded materials present additional external benefits not captured in life cycle cost analysis.

The Team conducted qualitative and quantitative analyses to examine the costs and benefits of various design elements used in City streetscape projects in order to develop a lifecycle costing model and a methodology to assess related externalities. The Team developed a model that included costs of constructing and maintaining a project over its entire useful life and applied the model to four DOT projects, with the goal of assessing their cost-effectiveness in the long-term.

APPENDIX E

LCCA Calculation Template for West Houston

Design Element:		West Houston			
		3%	5%	7%	
NPV: Standard Cost		$ 9,362,443.53	$ 6,373,055.84	$ 4,369,765.70	Twenty Years
Discount rate:		3.00%	5.00%	7.00%	
Analysis Period:		20.00	20.00	20.00	
One-Time costs:		$9,990,016.22	9,990,016.22	9,990,016.22	
Recurring Cost:		6,919,598.22	6,919,598.22	6,919,598.22	
Lifespan Calculation:	Years	Annuity Factor	Annuity Factor	Annuity Factor	
Ex Standard Material	20	$ 629,303.27	$ 511,390.49	$ 412,474.97	
NPV: Upgraded Cost		$ 10,272,830.37	$ 6,992,760.10	$ 4,794,673.70	
Discount rate:		3.00%	5.00%	7.00%	
Analysis Period:		20.00	20.00	20.00	
One-Time costs:		$10,538,102.85	10,538,102.85	10,538,102.85	
Recurring Cost:		8,015,771.48	8,015,771.48	8,015,771.48	
Lifespan Calculation:	Years	Annuity Factor	Annuity Factor	Annuity Factor	
Ex Upgraded Material	25	$ 537,665.20	$ 452,183.97	$ 374,971.85	
AF % Difference		-14.56%	-11.58%	-9.09%	
		3%	5%	7%	
NPV: Standard Cost		$ 8,391,928.68	$ 4,713,022.94	$ 2,675,871.14	Thirty Years
Discount rate:		3.00%	5.00%	7.00%	
Analysis Period:		30.00	30.00	30.00	
One-Time costs:		$9,990,016.22	9,990,016.22	9,990,016.22	
Recurring Cost:		10,379,397.33	10,379,397.33	10,379,397.33	
Lifespan Calculation:	Years	Annuity Factor	Annuity Factor	Annuity Factor	
Ex Standard Material	35.00	$ 390,554.42	$ 287,832.36	$ 206,668.12	
NPV: Upgraded Cost		$ 9,295,146.42	$ 5,220,282.48	$ 2,963,873.38	
Discount rate:		3.00%	5.00%	7.00%	
Analysis Period:		30.00	30.00	30.00	
One-Time costs:		$10,538,102.85	10,538,102.85	10,538,102.85	
Recurring Cost:		12,023,657.23	12,023,657.23	12,023,657.23	
Lifespan Calculation:	Years	Annuity Factor	Annuity Factor	Annuity Factor	
Ex Upgraded Material	40	$ 402,130.14	$ 304,228.46	$ 222,317.59	
AF % Difference		2.96%	5.70%	7.57%	
		3%	5%	7%	
NPV: Standard Cost		$ 9,817,320.11	$ 5,513,542.43	$ 3,130,374.97	Fourty Years
Discount rate:		3.00%	5.00%	7.00%	
Analysis Period:		30.00	30.00	30.00	
One-Time costs:		$9,990,016.22	9,990,016.22	9,990,016.22	
Recurring Cost:		13,839,196.44	13,839,196.44	13,839,196.44	
Lifespan Calculation:	Years	Annuity Factor	Annuity Factor	Annuity Factor	
Ex Standard Material	35.00	$ 456,891.12	$ 336,721.45	$ 241,771.25	
NPV: Upgraded Cost		$ 10,946,342.28	$ 6,147,616.86	$ 3,490,377.77	
Discount rate:		3.00%	5.00%	7.00%	
Analysis Period:		30.00	30.00	30.00	
One-Time costs:		$10,538,102.85	10,538,102.85	10,538,102.85	
Recurring Cost:		16,031,542.97	16,031,542.97	16,031,542.97	
Lifespan Calculation:	Years	Annuity Factor	Annuity Factor	Annuity Factor	
Ex Upgraded Material	40	$ 473,564.80	$ 358,271.81	$ 261,810.23	
AF % Difference		3.65%	6.40%	8.29%	

Transitioning into Lifecycle Cost Analysis |38

Source: NYU/Wagner project report, "Transitioning into Life Cycle Cost Analysis, p. 38.

In addition, the Team created a benefits matrix database and interactive scorecard methodology to assess the long-term benefits of these project types with respect to safety, mobility/accessibility, environmental health/sustainability and economic vitality.

Figure 5: Benefit Matrix

Qualitative Benefits for Treatments/Design Elements

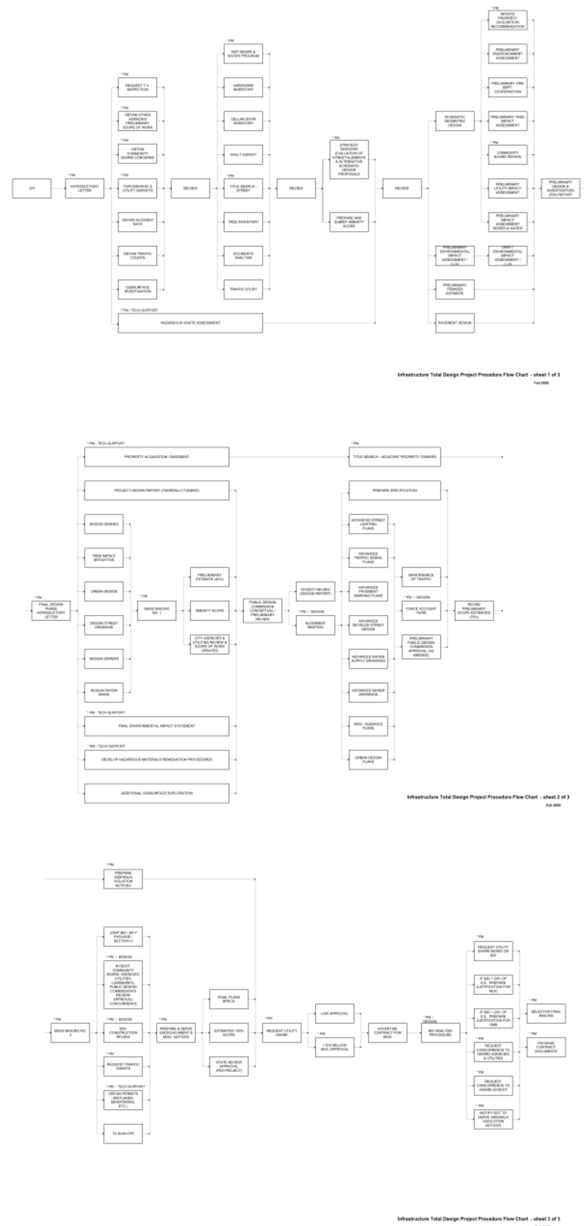
General qualitative assessments are outlined according to benefit categories, material and maintenance costs, and lifespan. This matrix is not intended to be comprehensive of all designs and treatments, nor is it intended to be comprehensive of all benefits from each design/treatment.

	Benefits				Costs		Lifespan
Design Element/Treatment	Mobility/Accessibility	Safety	Environmental Health & Sustainability	Economic Vitality	Material	Maintenance	Years
Bikes							
Class I Bike Path	Improved bicycle mobility and accessibility	Strong improvement in cyclist and pedestrian safety; Helps reduce traffic speeds; on road bike lanes reduce accidents by 50%	Reduces energy consumption by increasing bicycle use	Increased foot traffic due to traffic calming; Decreased transportation costs for employees/customers now accessing area by bike	*n/a	*n/a	*n/a
Class II Bike Lane	Improved bicycle mobility and accessibility	Moderate improvement in cyclist and pedestrian safety; Helps reduce traffic speeds; on road bike lanes reduce accidents by 50%	Reduces energy consumption by increasing bicycle use	Increased foot traffic due to traffic calming; Decreased transportation costs for employees/customers now accessing area by bike	*n/a	*n/a	*n/a
Sidewalks & Medians							
Curb Extension/Neckdown	Improves pedestrian mobility for seniors / people with limited mobility	Improves pedestrian safety; Helps reduce traffic speeds; Shortens crossing distances;	May encourage more walking by establishing safer pedestrian environment	Improved pedestrian environment and calmer traffic, which could lead to increased property values and retail sales by 20- 40%	*n/a	*n/a	*n/a
Curb Extension w/ Vegetation	Improves pedestrian mobility for seniors / people with limited mobility	Improves pedestrian safety; Helps reduce traffic speeds; Shortens crossing distances	Increases vegetation thus reducing pollution and urban heat island effect; Reduces negative environmental impact; May encourage more walking by establishing safer pedestrian environment	Improved pedestrian environment and calmer traffic, which could lead to increased property values and retail sales by 20-40%	*n/a	*n/a	*n/a
Median (no plantings)	Improves pedestrian accessibility in crossing the street	Improves pedestrian safety and helps calm traffic	–	Improved pedestrian environment and calmer traffic, which could lead to increased property values and retail sales by 20-40%	*n/a	*n/a	*n/a
Planted Median	Improves pedestrian accessibility in crossing the street	Improves pedestrian safety and helps calm traffic	Increases vegetation; increase water absorption reducing storm water runoff	Improved pedestrian environment and calmer traffic, which could lead to increased property values and retail sales 20-40%	*n/a	*n/a	*n/a
Standard Sidewalk	Standard pedestrian infrastructure	Standard Pedestrian infrastructure	–	–	$8.13 SF for 4" Thick $10.18 SF for 7" Thick	*n/a	15

Source: NYU/Wagner project report, "Transitioning into Life Cycle Cost Analysis, p. 23

In applying the lifecycle cost model to completed projects, the Team identified data gaps created, in part, by the complex system that consist of urban streets and, in part, by the government systems currently in place to collect cost data at the agencies involved with streets and public spaces. The matrix/scorecard analysis using available data suggested that, among design elements in current use, a combination of Class I bike paths, curb extensions with vegetation and planted medians ranked the highest in long-term benefits. The Team recommended steps to generate data currently missing or difficult to obtain, due, in part, the present state of operation and maintenance data at City agencies involved in maintaining the streets and public spaces.

The Port Authority of New York and New Jersey has developed a cost-benefit analysis framework as a tool for evaluating discretionary projects and prioritizing capital investments. It is now in the process of applying the methodology to individual projects. One question to consider in applying cost-benefit analysis to a project with multiple alternatives is the appropriate time to apply life-cycle costs analysis to help identify the preferred alternative. In the absence, or hidden nature, of necessary data for life-cycle costing at the city, the weighing of alternatives is limited to treating components beyond standard materials as "amenities" subject to additional justification or for constructability or scheduling issues. Were necessary data or proxies to be identified, life cycle costing could be applied earlier in the process to the scoping/conceptual design phase, taking in not only materials, but broader street design elements.



Source: DDC